

ACDA5010_OME_LWG_181035 1_Assignment

by William Groom

FILE	12118_WILLIAM_GROOM_ACDA5010_OME_LWG_1810351_ASSIGNMENT_233318_1793483360.DOCX (42.1K)		
TIME SUBMITTED	28-JUL-2020 11:31PM (UTC+0100)	WORD COUNT	2854
SUBMISSION ID	131923333	CHARACTER COUNT	15673

Ordinance, Munitions & Explosives (Degree Apprenticeship)

Process of Munitions Design

ACDA5010, Level 5, OME Principles

Groom Lawrence W - 1810351

[Date]

Contents

Introduction	1
Design Requirements	2
Cardinal points specification	2
Method/Thought Process'	3
Meeting of Requirements	3
Design Specification	4
Energetic materials	4
Initiation train and fusing system.	4
Casing	5
Guidance Solutions	5
Final Munition Design Outline	5
T&E of Design	6
Environmental and Specification Testing.....	6
Acceptance Testing	6
Post Procurement Considerations	7
Conclusion.....	7
References	8

Introduction

The process of assessing, designing, testing and delivering an energetic munition which meet and exceeds the customers stated requirements is not a trivial task. A designer will often employ systems thinking approaches in order to deliver a successful and safe product, as the need to understand and manipulate a complex and comparatively dangerous system such as those found in OME (Ordinance, Munitions and Explosives) design is a necessity. Firstly a designer must assess the customer requirements for viability whilst also accepting that these initial desires rarely provide enough information to inform a comprehensive design. They must continue to work with the customer to gain a full understanding of their wants and needs with regards to the design and then begin compiling possible solutions to meet these.

Solutions must then be compared and an option selected which in turn must be tested and evaluated against the requirements it has been selected to meet. Once a design has been finalised and component options selected and tested, the full design is then evaluated and, if successful, accepted by the customer.

The customer, with information and support from the designer, is then responsible for the munitions lifecycle management with regards to safe storage, use and disposal.

This assignment will breakdown and consider each aspect outlined above using the brief that a customer requires a guided, air dropped weapon to be delivered by a specified aircraft which is capable of defeating a building of specified design.

Design Requirements

While there is a need to meet customer specification, otherwise the resulting design may never be accepted, there are usually a large number of aspects that are overlooked or not considered at all by the customer, for example. The requirement for the munition to defeat a hardened target may not be descriptive enough to inform on a design parameter. Equally, cost will often be a customer procurement target and therefore it may be necessary to tailor a design accordingly. For example, it is generally considered that thermobaric devices are the best choice when defeating hardened targets such as bunkers or cave systems however, the design and development of such munitions are several times more expensive than selecting an aluminised explosive mixture, carried in a conventional but strengthened casing, which may well have enough destruction power to defeat the target the customer has in mind.

Cardinal points specification

The initial specifications laid out by the customer.

Target Definition and defeat criteria

- Munition must be capable of destroying hardened targets such as re-enforced, concrete bunkers
- Munition must be capable of penetrating 2 meters of reinforced concrete
- Delivery mechanism
- Air dropped from sub and super-sonic speeds
- Maximum weight of 2,000lb's, Net Explosives Quantity (NEQ), design dependant
- Maximum ceiling of munition 40,000 feet
- Capable of both internal (bomb bay) and external carry by fixed wing air platform
- Storage, transport, stowage and loading conditions
- Munition must have service life of 5 years in storage or 1 active mission
- Life cycle suitable for munition of its weight class

Method/Thought Process'

In effect the thought or method process section of a design is used to get from the cardinal points (the top level requirements) to something that is more useable and informative to a design team.

It is important to continually assess the initial or cardinal requirements throughout the design assessment in order to ensure the developing ideas are still meeting the outline brief. The thought process, or processes, employed to delve deeper into the initial requirements is a key stage of assessing the design requirements and formulating an approach to meet them.

Tools such as Use Cases can be used to analyse exactly how a munition functions in a step by step way; they can also help with highlighting where errors, be it safety or mechanical, may become relevant. Multiple use cases can be drawn up for every aspect of the munitions lifecycle, from production, to storage, use and disposal.

A critical aspect of the thought process is to gain an understanding of how exactly the munition will function. Once this is fully understood, concepts on how this function might be achieved can be explored. It is important to look beyond current in-service solutions as this is how advancements are made, however it then becomes necessary to assess further impacts and the potential need for other new technologies to support the initial novel thought. For example if a method of case filling that can dramatically increase production is identified, resulting in a greater output from the production plant, then the impact on material supply chains, storage and logistics will need to be assessed as well. Additionally it may become necessary to use a new drying process in order to supply material at the increased pace. It is important to maintain a systems design viewpoint and be aware of how and where changes can affect the system as a whole.

It is unlikely that a comprehensive list of requirements will be issued from the start. This is largely due to the complex nature of typical procurement pathways as well as a wide range of requirements across the relevant stake holders. For example, the user (i.e. the pilot dropping the munition) may want the munition to be as light as possible so they can carry more than one or two, whereas AWC (Air Warfare Centre) may require the device to be of a certain size and weight for logistical purposes; these opposing requirements create a conflict before anything is formally issued. Is it therefore imperative that a designer engages with stakeholders in order to tease out additional requirements that may not have been specified in the first instance.

Meeting of Requirements

One of the first steps in meeting customer requirements is to order said requirements into priorities. This will allow the designer to start identifying where design time needs to be focused, what challenges are likely to be faced and how the design process may be laid out. For example, if the customer's top priority is that the munition must have a storage and use

life cycle of fifty years, it is likely that the designer may first focus on the munitions explosive material design, specifically to achieve a material that does not degrade over time. By prioritising the requirements list, further areas or elements may be highlighted that would exceed the original requirements, such as developing multiple aiming and guidance solutions in order to improve munition accuracy in a range of environments/adverse weather conditions. Conversely, while prioritising requirements is a beneficial step, and helps to identify what elements the customer is most interested in, it is important to ensure that every requirement stated by the customer is, at least, met; providing these elements are realistic.

Design Specification

Energetic materials

In order to create enough destructive force to destroy a hardened emplacement such as a re-enforced concrete bunker, as desired in the initial requirements, there are two basic options. Either an unrealistically large quantity of conventional military grade explosive such as a standard RDX/TNT wax can be used, or a more powerful but non-general explosive main fill must be used. As stated above, a conventional explosive fill will put the design of the munition over the weight limit set by the customer. Additionally, while the detonative force of a conventional explosive is great, it is desirable to also increase the impulse of the pressure event, as well as the negative phase, improving the explosives effectiveness against structures due to the increase in “pushing” force. As a result, a less conventional energetic material needs to be sought in order to fulfil these requirements. For this reason, a thermobaric or fuel air explosive was investigated. A thermobaric munition creates, in effect, a secondary detonation a short time after its initial event (micro to millisecond delay). This is achieved through the use of a two part charge, typically a central core of high explosive which detonates first, ejecting the surrounding secondary charge. This secondary charge is rarely a solid item but rather a liquid or powder which, when ejected, utilises the oxygen in the surrounding atmosphere as its oxidiser, and when detonated, creates a massive secondary pressure event. This allows the extension of the overpressure event created from explosive detonation and dramatically increases the materials destructive effect on hard targets. [1]

Initiation train and fusing system.

As this munition design will impact hard targets at great speed in order to penetrate the target, it is obvious that the fusing and SAU (Safety arming unit) has a requirement to be rugged and protected where possible. Furthermore the nature of the design being a 2000lb munition adds an increased level of safety requirements, and so the SAU must only be

activated when absolutely necessary. The performance of the fuse must also be assessed as a level of timing is required in order to allow the munition to penetrate the target. As a result of these requirements the FMU-167B fuse was selected as the best option for this munition. Further information can be found at [2].

Casing

As outlined in the requirements, the munition will be expected to penetrate several meters of re-enforced concrete, this suggests the munition casing (body) will need to be made of a material strong and thick enough to withstand excessive compressive forces as the payload impacts and buries into the target. Historically a thick (25mm) steel casing was used to provide protection to the main fill, with the outer geometry and thicker nose section employed to provide the penetrative effect. [3] Due to the requirement of the munition to penetrate a relatively small amount of re-enforced concrete (>4m) a similar approach is suggested, but with the use of new steel alloy's to further improve strength. A steel alloy such as AF96 which displays a high strength and impact yield when compared to conventional alloys. [4] This steel is used in the manufacture of "bunker buster" munitions designed to penetrate 5 or more meters of concrete.

Guidance Solutions

GPS guidance was selected as the primary system to be used, with an option to install laser guidance components should a sortie require target laser identification by personnel on the ground. This use of GPS as a primary guidance system is in part due to the relatively unreliable nature of conventional laser guidance systems when cloud cover or harsh weather conditions are present. [5]

Final Munition Design Outline

Basic outline will be a bomb casing designed from the BLU 109 in-service system however with a redefined metallurgy of Af96 steel, specifically designed for thermobaric, ground penetrating air dropped weapons and a slightly thickened nose section. This will not compromise explosive yield as the H-TBX thermobaric explosive fill will be of a lower NEQ than that of a standard PBX or RDX/TNT main fill commonly found in BLU109's. This allows for the well understood geometry of a BLU 109 with the improved ground penetration afforded by the new metal alloy as well as a main fill specifically designed to damage and destroy re-enforced targets such as bunkers and cave systems. A rear fusing design will be a programmable FMU-167B SAU (Safety arm unit). The initiation train will consist of a fuse

which, when initiated at the correct time delay/depth/location will ignite the booster, which in turn will detonate the centrally located primary charge. This primary charge will rupture the outer body of the munition and disperse the secondary charge which encases the primary. This secondary charge is fuel heavy and powdered so as to disperse into the atmosphere upon case rupture, and the flash over from the primary charge will begin to burn the now aerosolised secondary which will consume oxygen directly from the atmosphere and use this to burn rapidly. This secondary burn will create a massive overpressure and corresponding negative phase which will further assist in the destruction of the target and anything within it.

T&E of Design

While munition design tests are crucial it is equally important to test process and production systems and procedures, such as the method by which the casing is filled. This testing helps to inform on production efficiency, capacity and scale while also providing information on where further noises may be present such as bottle necks or raw material supply.

Environmental and Specification Testing

It is important to test every aspect of a design rigorously in order to avoid a partial or full re-design. Additionally continuous testing throughout the design phase will assist in the identification of noises, flaws and or errors within the design.

Environmental testing such as performed by the Defence Ordnance Safety Group (DOS-G) in order to fully characterise not only the explosive fill but the entire design as a fully assembled item. Testing such as rapid aging, heat cycling, and vibration test set to specific frequencies as found on cargo planes, military transport and other vehicles likely encountered by the munition. Aggressive testing such as fragment impact to assess the feasibility of sympathetic detonation and drop testing to ensure munition survivability in the event of an incident. All tests relating to new or in-service explosive articles are conducted in accordance with DSA-3 OME: In-Service and Operational Safety Management [6]

Acceptance Testing

Once the design has passed environmental and design proof testing it is then required to be acceptance tested. This is a series of live trials whereby the munition is assessed against the customer requirements and examined on its performance within certain situations. For example a munition will undergo several live-fire tests against simulated targets in order to assess its effectiveness, which is in turn compared to the design requirements. Feedback from users is also collected at this point such as input from the pilot or loading technicians. This feedback is then fed back into the design programme in order to make final design adjustments or in preparation for future design development.

Post Procurement Considerations

Once a munition is accepted into service by the customer, it is their responsibility to ensure post acceptance handling and storage is carried out correctly, to guidelines and relevant legislation such as DSA03 – OME [6]. The user is responsible for the management of munition life cycle and disposal pathways, as well as having documentation to track any given munition's current status. For example, the tracking and logging of munition transport, storage locations and if it has been loaded for a sortie, i.e. onto an air platform and flown. Using environmental testing results as conducted as part of the design phase, guidelines and thresholds for the munition will be followed, for example if any given munition is exposed to temperature outside of the testing performed then said munition will be quarantined for inspection and disposed of using appropriate pathways.

Conclusion

To summarise, aspects of a munitions design cycle, including post procurement, were assessed with examples given of design choices and reasons. Acceptance that initial requirements are often not all-inclusive but must still be met, less the design be rejected, as well as the need to identify which of these requirements may take a priority, is a fundamental first step in the design process. While meeting requirements through the use of available tools to assess design options, researching historical information and utilising novel ideas and techniques as well as understanding that said novel thinking may require additional technological challenges are all key aspects a good initial design phase. Environmental and safety testing of a physical design (the munition) as well as production process and procedures are not only vital but legally required to be carried out. Design adjustments as a result of these tests are often required, as noise management though the design phase, while thorough, is unlikely to catch every flaw in a large, complex and rapidly evolving system. Whilst OME design encompasses the whole life cycle of the finished article, including the safe disposal, it is not the designers' responsibility to dispose of the designed item in question, however all procedures and pathways must be accounted for during the initial design process.

References

- [1] L. Türker, "Thermobaric and enhanced blast explosives (TBX and EBX)," Department of Chemistry, Middle East Technical University, Ankara, Turkey, Ankara, 2016.
- [2] AirForce Technology , "AirForce-Technology," Verdict Media Limited, [Online]. Available: <https://www.airforce-technology.com/news/usaf-northrop-grumman-fuze/>. [Accessed 27 07 2020].
- [3] FI-AEROWEB, "FI-AEROWEB.com," Forcast International inc. , [Online]. Available: <http://www.fi-aeroweb.com/Defense/General-Purpose-Bombs.html>. [Accessed 27 07 2020].
- [4] Federal Laboratory Consortium for Technology Transfer, "Federallabs.org," Federal Laboratory Consortium for Technology Transfer, [Online]. Available: <https://federallabs.org/successes/awards/awards-gallery/2018/af96-low-alloy-high-performance-steel>. [Accessed 27 07 2020].
- [5] J. Pike, "Military Analysis Network," Federation of American Scientists, 12 02 2000. [Online]. Available: <https://fas.org/man/dod-101/sys/smart/lgb.htm>. [Accessed 27 07 2020].
- [6] Uk Government , "Gov.uk," Government Digital Services, 18 06 2020. [Online]. Available: <https://www.gov.uk/government/publications/dsa03-ome-part-2-in-service-and-operational-safety-management-of-ome>. [Accessed 27 07 2020].
- [7] J. Akhavan, The Chemisrty of Explosives, 3rd additon, Cambridge: RSC, 2011.

FINAL GRADE

GENERAL COMMENTS

Instructor

69/100

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

GRADING FORM: SMU GENERIC_GJ

WILLIAM
GROOM

69

RESEARCH-INFORMED LITERATURE



Environmental and performance aspects covered.
Some interaction with regulatory publications (JSP
482 / DSA03) required .

5.9

KNOWLEDGE AND UNDERSTANDING



Domain knowledge is good but would have like to
have seen a "pros and cons" table comparing the
selected device with more conventional options.
Environmental considerations included in discussion

22.5

ANALYSIS



Very good presentation of ideas and concepts.
Systems thinking in evidence

20.7

PRACTICAL APPLICATION AND DEP.



Systems tools and techniques recognised.
Requirements analysis good

13

SKILLS FOR PROFESSIONAL PRAC.



Communication clear and logical

6.9